20 November 1962
GSG Report No. 1183.00/35
FR 62-11-128

BI-MONTHLY PROGRESS REPORT
ON
COLLECTIVE PROTECTION EQUIPMENT
FOR THE
AN/MSG-4 SYSTEM
PHASE II
DEVELOPMENT, FABRICATION, AND TEST

CONTRACT NO: DA-18-108 CML-6618 (AMC 28A)

REPORT PERIOD: Technical Report 1 September to 31 October 1962 (4th Report)

TO: Commanding Officer
U. S. Army Chemical Research and Development Laboratories
Edgewood Arsenal, Maryland

ATTENTION: Contract Project Officer

PHASE II

The Phase II Contract, executed September 1962, authorizes the continued development of Collective Protection Equipment and further provides for delivery of additional items of relative equipment and the performance of services encompassing the activities of Maintenance Engineering, Value Engineering, and Data Submittal.

Historically, Phase IA initiated to develop prototype hardware for purposes of maintaining continuity with the Phase I Feasibility and Design Study for Collective Protection Equipment for the AN/MSG-4 System, was restricted to a best effort within limited funding priority basis. Future reports will abstain from further reference to Phase IA since all work, presently contracted for, is considered within the overall scope of Phase II.

GENERAL

During this first Phase II reporting period, effort was devoted primarily to assembly and completion of prototype equipment, formal preparation of evaluation test procedures, and the conduct of Contractor evaluation testing. Significant items relevant to this scope of work are identified as:

1. 400 CFM Filter Unit
2. 800 CFM Filter Unit
3. Remote Control Panels
4. AN/MSQ-28 WMC/RDPC Protective Entrance
5. AN/TSQ-38 Protective Entrance
6. Miscellaneous items described as flexible air ducts, power and control cables, and air duct storage racks.

CUSTOMER COORDINATION

1. Messrs. M. D. Mears, U. S. Army Chemical Research and Development Laboratory, Edgewood Arsenal, and G. H. Denoncourt, U. S. Army Proving Grounds, Dugway, Utah, visited this contractor's facility during the week of 10 September. Among items inspected and discussed during this visit were the 400 CFM Filter Unit and Remote Control Panel, skid base and support legs, stowage box, and the WMC/RDPC Protective Entrance. (See Figure 3.)

2. On 26 October, Mr. J. C. Groff, representing Hughes Aircraft Company, visited Edgewood Arsenal to confer with Chemical Corps representatives regarding the test and evaluation program, for Hughes equipment, in progress at CRDL. Equipment photographs and contractor preliminary test data were presented.

DESIGN PROGRESS

1. Excluding Collective Protection Equipment peculiarly applicable to the AN/GSS-1D, the final design configuration of all prototype equipment is considered firm.

   For informative purposes, photographs and descriptive design features are included as an addendum to this report.

2. AN/GSS-1D

Design effort directed towards establishing filter unit performance requirements was hampered during this reporting period due to unsuccessful attempts to obtain more complete and reliable information relative to the AN/GSS-1D System. Data contained in the specifications, microfilm drawings, technical manuals, and test reports received thus far, lack specific information with respect to a) installed equipment and/or internal wiring, and b) maximum safe operating temperature for electronic equipment.

Effort will continue to establish design requirements, based upon a "best engineering judgement" safe maximum temperature, concurrent with a continued search for more factual data. Contractor tests of the 400 CFM Filter Prototype Unit proved that a 7° to 10° temperature rise is experienced in the air stream as it passes through the blower. With air filtration equipment and connecting ducts exposed to solar radiation in a desert climatic environment, air entering the shelter is conservatively estimated at 12° to 15°F higher than ambient. This condition, coupled with the recommendation contained in Test Report #T-1381, makes conclusive the requirement that air conditioning is necessary for successful operation of an AN/GSS-1D System. In view of the lack of consideration afforded this contingency in the Phase II Contract, there appears an urgent need for a mutually agreed course of action between Contractor and CRDL, as affects further development of the filter unit for AN/GSS-1D application.

3. Preliminary studies to determine vehicle/shelter modifications and installation kit requirements, have been reviewed. Analysis, thus far, indicates conformity with the requirements outlined in the Feasibility and Design Study Final Report #FD 62-75.

DRAWING PROGRESS

Drawings, completed and released during the last reporting period, are being revised to incorporate those necessary design and corrective changes incurred during prototype fabrication and testing.

FABRICATION PROGRESS

1. The first prototype 400 CFM Filter Unit and its attendant Remote Control Panel was completed, tested, and shipped (F.O.B. Fullerton) 5 October 1962, one week ahead of Contract schedule.

2. The first prototype 800 CFM Filter Unit and its attendant Remote Control Panel was completed, tested, and shipped (F.O.B. Fullerton) 12 October 1962, on Contract schedule.

3. The first prototype WMC/RDPC AN/MSQ-28 Protective Entrance fabric assembly, revised to incorporate pressure sealing slide fasteners, was completed, tested, and delivered (F.O.B. Fullerton) 2 November 1962.

4. The first prototype AN/TSQ-38 Protective Entrance fabric assembly has been modified to incorporate pressure sealing slide fasteners. Performance test preparations were underway at the close of the reporting period. Assuming satisfactory performance, it is anticipated that this protective entrance will be shipped (F.O.B. Fullerton) 16 November 1962.

TEST PROGRESS

400 CFM Filter Unit

The first prototype 400 CFM Filter Unit, tested in accordance with HAC Test Procedure #X1501802, Revision A, proved the Filter Unit capable of delivering air to two locations simultaneously, at different flow rates and back pressures, under simulated vehicle installation conditions. (See Figure 9.)

In addition the capability of the automatic damper system to regulate pressure was established. (See Figure 10.)

800 CFM Filter Unit

The first prototype 800 CFM Filter Unit was tested in accordance with HAC Test Procedure #X1501803, Revision A, to determine air delivery versus back pressure characteristics and to assure proper parallel operation of the automatic damper systems when supplying air to a common plenum. Figures 14 and 15 chart satisfactory demonstration.

AN/MPS-23 Radar Antenna Trailer Evaluation (See Figure 16)

Operation of the 800 CFM Filter Unit with a functional AN/MPS-23 Radar Antenna Trailer, utilizing a new radome, indicated air delivery requirement to be approximately 210 CFM, a quantity considerably below expectations. Successful consummation of tests conducted with only one 400 CFM Filter Unit, presents a strong but tentative opinion that the single module would suffice for this application.

AN/MSQ-28 WMC/RDPC Protective Entrance

Tests successfully accomplished in accordance with HAC Test Procedure #X1501804, determined total leakage rate of the protective entrance and the leakage rate at each of the major contributing sources at various internal pressures.

Table 1 provides a comparative analysis of the entrance test results before and after the pressure sealing zipper modification.

Table 1

PROTECTIVE ENTRANCE AIR LEAKAGE RATES IN CFM DURING PRESSURIZATION AT 1.6" W.G.

ITEM NUMBER	LEAKAGE SOURCE	TEST 1 V-F 106 SLIDE FASTENER ON DOOR COUPLING	TEST 2 B.F. GOODRICH PRESSURE SEALING SLIDE FASTENER
1	Door Coupling Slide Fastener	48	2
2	Disposal Opening Slide Fastener (Closed)	3	9
3	Exhaust Openings Slide Fasteners (Closed)	5	10
4	Personnel Opening Slide Fasteners (Closed)	22	44
5	Unaccounted for	92	30
	TOTAL AIR SUPPLIED TO THE PROTECTIVE ENTRANCE TO MAINTAIN PRESSURE	170	95

Maintenance Engineering

Ease of maintenance check list preliminary drafts, prepared in accordance with the requirements of Specification EP-2, Maintenance Engineering Requirements for Chemical Corps Equipment, account for (a) 400 CFM Filter Unit, (b) 800 CFM Filter Unit, (c) Skid Base and Legs, and (d) Storage Box. In addition, maintenance support plan preliminary drafts have been prepared to cover (a) 400 CFM Filter Unit, (b) Protective Entrance, (c) Installation Kit, and (d) Vehicle Mod Kits. Telephone authorization for deletion of EP-2 requirements for the maintenance support plan, Sections 3, 5, and 8, was granted by Mr. Roy Antetomaso, Chief, Maintenance Engineering Branch, Army Chemical Corps. Review of the preliminary drafts with Maintenance Engineering Branch personnel will be accomplished during the next reporting period.

Value Engineering

Preliminary study of, and a general familiarization with, Collective Protection Equipment design detail has been accomplished. Total system function and subsidiary system element functions were listed to serve as the basis for cost grouping and isolation of those areas providing the most value improvement potential. A listing of all purchased items indicating cost, quantity, and available suppliers is being generated to serve as the basis for sole source selection and/or high cost items for value improvement.

Financial Summary

The funds expended, manhours expended, estimated costs for the next reporting period, and the balance of contract funds are shown in the following chart. Dollars shown exclude fee.

September and October 1962		Phase II Cumulative Through October 1962		Estimated for November and December 1962	
Man Hours	Total $ including material	Man Hours	Total $ including material	Man Hours	Total $ including material
6,541	$72,388.00	22,972	$248,621.00	5,040	$75,000.00

Contract Cost Funds	$1,025,683.00
Less Cumulative Costs	$ 248,621.00
Balance Remaining	$ 777,062.00

PLANNED ACTIVITY FOR NEXT REPORTING PERIOD

1. Fabrication completion, test, and shipment of AN/MSQ-28 WMC/RDPC Protective Entrance.

2. Fabrication completion, test, and shipment of AN/TSQ-38 Protective Entrance.

3. Completion and official submittal of evaluation and test procedures, plus attendant test data applicable to the 400 and 800 CFM Filter Units.

4. Completion and official submittal of evaluation and test procedures, plus attendant test data applicable to the WMC/RDPC and AN/TSQ-38 Protective Entrances.

5. Assuming timely receipt of Army Chemical Center evaluation, equipment design modification recommendations will be reviewed.

6. Advance bills of material will be issued to cover long procurement lead time items for 400 and 800 CFM Filter Unit final prototypes.

7. An advance bill of material will be issued to cover the butyl covered nylon fabric and slide fasteners required for the three final prototype protective entrances.

8. Major design and drafting effort will be concentrated on the three new prototype entrance models.

9. Establish the firm engineering design concept for the vehicle/shelter modifications and attendant Collective Protection Equipment installation kits.

10. Availability of an AN/MPS-23 Radar Equipment Trailer during the first week in November will provide for the conduct of a brief operational test to determine the sufficiency of a 400 CFM Filter Unit for this trailer's support.

11. Considerable effort will be directed toward resolution of basic design requirements for the AN/GSS-1D Filter Unit. It is further planned to hold coordinative discussions with CRDL to resolve the course of development.

12. Assuming the establishment of coordinated ground rules at the forthcoming conference with Army Chemical Corps Maintenance Engineering Branch, the maintenance support plan and ease of maintenance check list for AN/MSQ-28 Collective Protection Equipment will undergo some revision. It is also anticipated that equivalent equipment maintenance support plans and ease of maintenance check lists will be prepared for application to AN/TSQ-38.

13. Value Engineering effort will continue in the areas of isolating high cost components, determination of sole source, identification of large quantity items, and selection of alternate suppliers. The preliminary study of manufacturing methods is anticipated for completion during this next reporting period. It is further expected that some testing of alternative components will be conducted.

HUGHES AIRCRAFT COMPANY
Ground Systems Group

J. Glaser
Project Head

ADDENDUM

For informative purposes and ready reference, this addendum will provide descriptive design features of Collective Protection Equipment developed thus far. Concurrent with future equipment development, applicable descriptive narrative will augment future reports.

400 CFM FILTER UNIT

GENERAL

The basic 400 CFM Filter Unit module is designed to provide air, cleansed of chemical, bacteriological, and radiological agents, to those vehicles and shelters peculiar to the AN/MSG-4 Anti-Aircraft Defense System. This filtered air is supplied simultaneously to two separate areas (vehicle/shelter and protective entrance) at different flow rates and back pressures for each area.

Basic component makeup of the 400 CFM Filter Unit provides a pre-filter, one particulate filter, four gas filters, an automatic pressure regulating system, two manual dampers, and a centrifugal blower with integral motor and electrical control.

Figures 1, 2, and 12 illustrate the inherent design versatility permitting unit orientation, either vertically or horizontally, to meet the different mounting and operational requirements. Figure 4 provides a ready reference to component identity in block diagram form.

The 400 CFM Filter Unit is 18.38" wide, 24.12" deep, and 63" long (to the flange of the air discharge opening). Total weight, minus accessories, is 365 pounds. The unit is designed to operate on either 208V or 416V, 3 phase, 60 cps, 4 wire service. At rated air flow and nominal voltage, the blower motor draws approximately 2.5 amperes when operated at 208V, and 2.7 amperes at 416V.

DESIGN DETAIL

a) Pre-Filter

A dust and lint filter, provided in front of the blower to remove large particles, serves to extend the particulate filter's useful life. Location of this filter under the weather shield at the Filter Unit intake, provides easy acess for quick replacement.

b) Particulate Filter

The particulate filter, with 99.7% efficiency by Dioctyl-Phthalate Test (DOP) serves the function of removing aerosols and dust particle vehicles for bacteria and radioactive particles. The prototype particulate filter is evident in the right hand side of Figure 5.

c) Gas Filter

Four gas filters, each containing twenty four (24) pounds of activated charcoal, operate in parallel downstream of the particulate filter, to remove all gaseous and vaporous contaminants. The filters are located so as to remove re-evaporated aerosols which are first trapped by the particulate filter in liquid form. The left side of Figure 5 illustrates the assembly of four gas filters with their attendant separators.

d) Blower and Motor

The blower is Torrington Manufacturing Co.'s Model SC1024-16411 centrifugal fan provided with a shaft mounted wheel containing forward curved blades. The integral pancake type motor is 1.8 HP, two pole, designed for use with 4 wire, 208V or 416V, 3 phase, 60 cps power.

e) Automatic Pressure Regulating System

The Filter Unit incorporates an automatic damper, which serves the purpose of controlling pressure in protected areas remote from the unit. Under normal operating circumstances, the Filter Unit supplies air to the vehicle/shelter via the protected equipment's integral or remote air conditioner. The automatic damper keeps the air conditioner blower inlet plenum (lowest pressure point in the air conditioning system) at a positive pressure of from 0.45 to 0.60 inches W.G. with respect to the surrounding ambient air. As the filters become loaded, a pressure sensing switch signals the damper drive motor to properly position the damper to balance for the resulting pressure drop increase. In addition, the automatic damper compensates for pressure fluctuations, caused by voltage and frequency variations and/or variations in air delivery duct resistance.

The drive motor selected is a Barber-Colman MF-452 reversible shading coil motor requiring 208V, single phase, 60 cps power. Timing for 180° of motor shaft rotation is adjustable between 80 and 800 seconds. All units delivered to CRDL were operated in Contractor test, adjusted for 180 to 200 seconds for full travel.

The pressure switch selected is an F.W. Dwyer Manufacturing Company Model 1627-1 differential pressure switch. Pressure differential acting across the diaphragm actuates two switches controlling rotation direction of the damper drive motor. The switches of the 400 CFM Filter Unit were set between 0.45 and 0.60 inches W.G. to maintain delivered air pressure to a remote location.

f) Manual Dampers

The filter unit incorporates manual dampers in the two discharge connections to enable balance of flows and pressures between the vehicle/shelter and its protective entrance.

g) Operational Power Changes

Change from one voltage to the other, accomplished by simple connection and heater strip exchange is detailed on an instruction plate, located inside the remote control panel cover.

h) Filter Assembly

Figure 6 shows the complete filter assembly (one particulate filter, four gas filters) partially inserted into the filter unit. Holes in the particulate filter flange meet with alignment pins in the filter inlet plenum to prevent relative motion between filter and plenum. Unit design provides for maintenance of firm pressure on all gaskets to preclude inherent age set deterioration of sealing characteristics.

Figures 5 and 6 illustrate accomplishment of this objective as follows:

1. Gaskets between gas filters and spacers are under the constant pressure of four compression springs used with the tie rods which hold the gas filter subassembly together.

2. Gaskets at inlet and outlet plenums and the gaskets between gas filter subassembly and particulate filter are held under constant pressure of twelve springs holding the Top Assembly (Figure 7) firm against the filter assembly.

Bolts are inserted through the top assembly into the spring loaded blocks shown in Figure 8. As the bolts are secured, the blocks are pulled up against the outside surface of the top assembly, placing the springs under tension.

REMOTE CONTROL PANEL (See Figure 11)

GENERAL

The Remote Control Panel measures 16" in length, 10" in depth, and 7.35" in height. In its water tight aluminum carrying case, total weight equals twenty three (23) pounds. The hinged cover may be either opened or easily removed for access to the controls. The remote control panel portable design provides for controlling and monitoring filter unit operation from the "safe" confine of the vehicle/shelter. This singular design serves all equipment configurations, thereby eliminating the requirement for installation and design of control panels unique to each vehicle/shelter configuration.

DETAIL DESIGN FEATURES

a) Circuit Protection

A circuit breaker protecting all remote control panel and filter unit wiring also serves the convenient purpose of shutting off power for inspection and minor servicing.

b) Control Transformer

A transformer employed in the control circuit accomodates changeover to 416V power by means of simple wire connection exchange.

c) Differential Pressure Gage

An F.W. Dwyer Manufacturing Company Magnehelic pressure differential gage scaled from zero to 1.0" W.G. monitors the critical pressure differential between the vehicle/shelter air handling system low pressure point and ambient atmospheric pressure.

d) Malfunction Signal

The red malfunction light signals overload or malfunction, when the circuit breaker is in the "on" position and the blower motor is off.

e) "Damper Full Open" Warning

As the filters load with contaminants, or other system malfunctions occur, the automatic damper will open to maintain regulated pressure within proper limits. An amber warning light is energized when all reserve static head has been used and the automatic damper is full open.

f) Phase Reversal

An amber warning light signals incorrect power phasing. Corrective procedures are prescribed on the instruction plate.

g) Blower "On-Off" Switch

A holding circuit in the blower motor relay permits use of a momentary contact switch.

h) Pressure Switch Override

Automatic damper "Manual" or "Automatic" modes of operation are selected by means of a two position toggle switch. "Automatic" position provides for damper control by the differential pressure switch.

i) Damper Manual Control

A two position spring-loaded "Center" - "Off" toggle switch provides for manual actuation of the automatic damper only when the pressure switch override is in the "Manual" position. When the damper manual control switch is released, the damper blade will remain stationary.

j) Spare Fuses

Two control circuit fuses are provided in the carrying case cover.

k) Motor Starter Heater Elements

A bracket in the bottom of the control panel carrying case provides stowage for two heater elements for use on alternate operating voltages.

800 CFM FILTER UNIT (See Figure 13)

The 800 CFM Filter Unit, designed to a modular concept and composed of two standard 400 CFM Filter Units, will provide CBR protection to the normally unmanned AN/MPS-23 Radar Antenna Trailer. Major components contained in this unit have been designed for multiple usage, as evidenced by the standardized remote control panels previously described. The stowage box and skid base with detachable supports, are applicable in their singular configuration to the AN/TSQ-38 and AN/MSQ-18 Systems.

Size of the 800 CFM Filter Unit approximates 66" in length, 26" in width, and stands 69" high from the bottom of the skid base. The total assembly weight of 973 pounds is distributed as follows:

Stowage Box (empty) - 77 lb.

Two 400 CFM Filter Units - 730 lb.

Two Control Panels - 46 lb.

Skid Base with Legs - 120 lb.

DESIGN DETAIL FEATURES

a) Skid Base

Skid base design features openings on each side to permit fork lifting. In the event of shallow insertion, the forks are restrained by means of inverted channels inside the base. Four tubular legs, easily fitted into skid base sockets, serve to elevate the base approximately 10" above ground level. Tie rod installation locks the legs in place.

b) Stowage Box

This standardized compartment, located atop the two filter units, provides stowage for cables, air ducts, remote control panel(s), protective entrance, support beam, and all other accessories required for system installation. Internal dimensions approximate 59" in length, 22.5" in depth, and 22.5" in height. Hoisting provisions are evident in integral lifting rings. Two integral hinged brackets serve as support for the remote control panels during filter unit operation.

PROTECTIVE ENTRANCE

GENERAL

A pressurized protective entrance, provided for each shelter or vehicle, will permit safe personnel entry and exit without admitting CBR agents or adversely disturbing system pressurization. Upon entering the protected area from the external environment, personnel will remove their contaminated clothing within the protective entrance, discard by means of the disposal chute, cleanse themselves with decontaminating agents before making entry into the safeguarded area.

DETAIL DESIGN FEATURES

Basic design features have not varied to any significant degree from that outlined in the Phase I Feasibility and Design Study Final Report. Minor changes, coordinated with CRDL and incorporated in the prototype, are described as follows:

1. Puncture protection improved by addition of scuff pads to inside and outside surfaces of the protective entrance bottom.

2. Addition of a scuff pad to the door frame coupling to improve abrasion resistance where the entrance comes into contact with the trailer structure.

3. Use of B. F. Goodrich pressure sealing slide fasteners at the trailer door coupling.

4. Revised personnel entrance opening from rectangular to a curved configuration.

Figures 17 through 24 illustrate several of the more significant Protective Entrance detail design features.

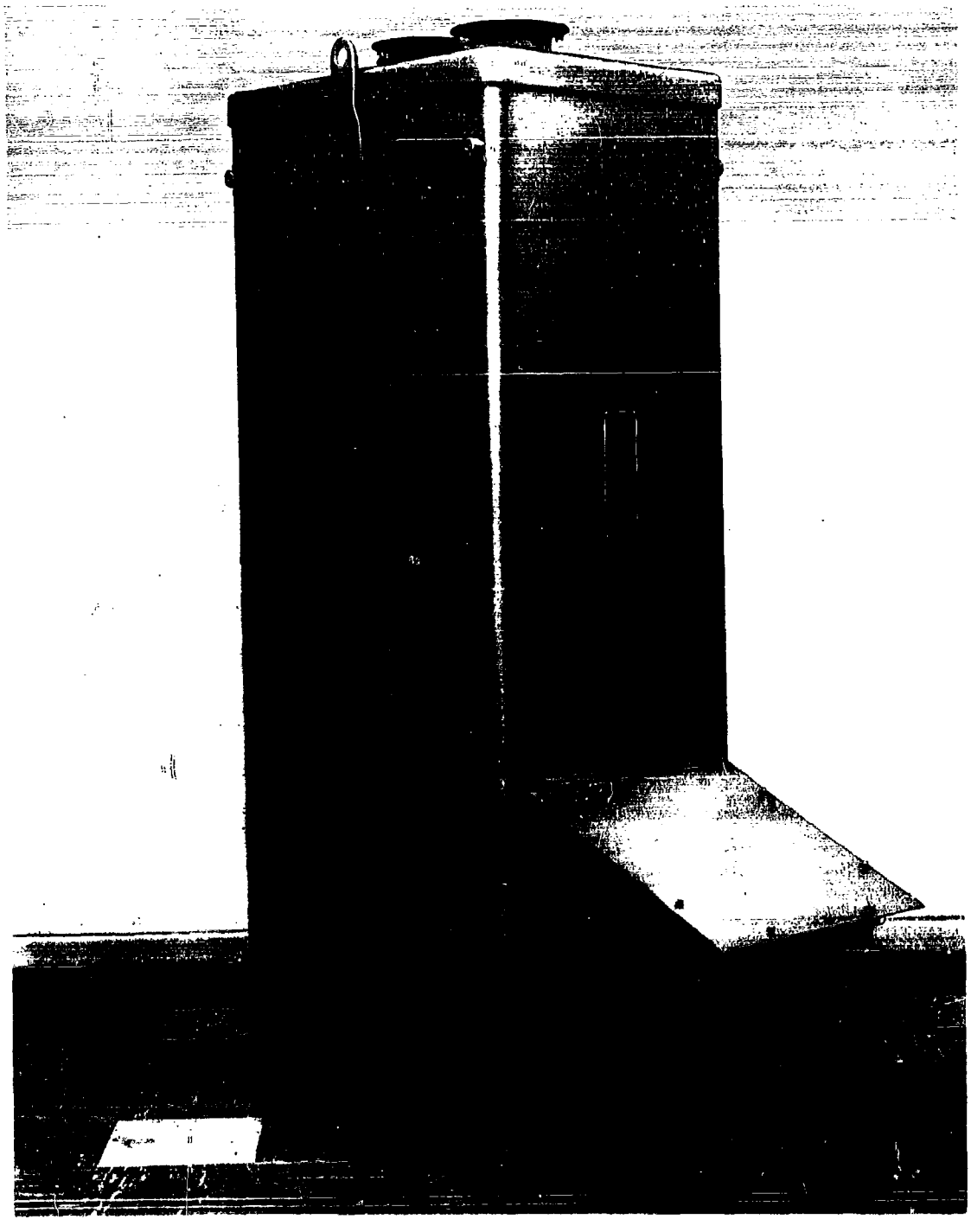


Figure 1. Prototype 400 CFM Filter Unit in Vertical Position.

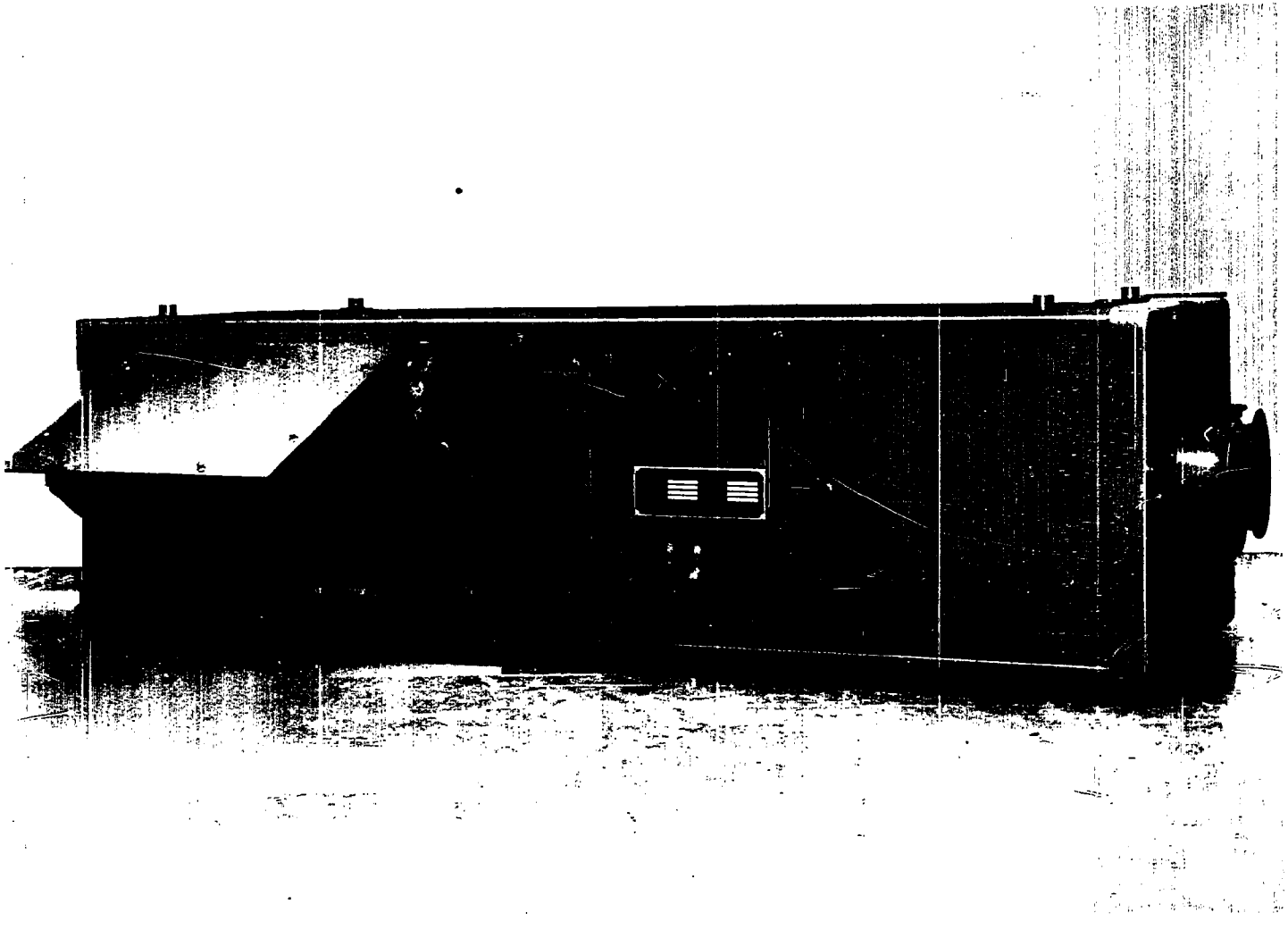


Figure 2. Prototype 400 CFM Filter Unit in Horizontal Position.

Figure 3. Customer Inspection of Prototype 400 CFM Filter Unit.

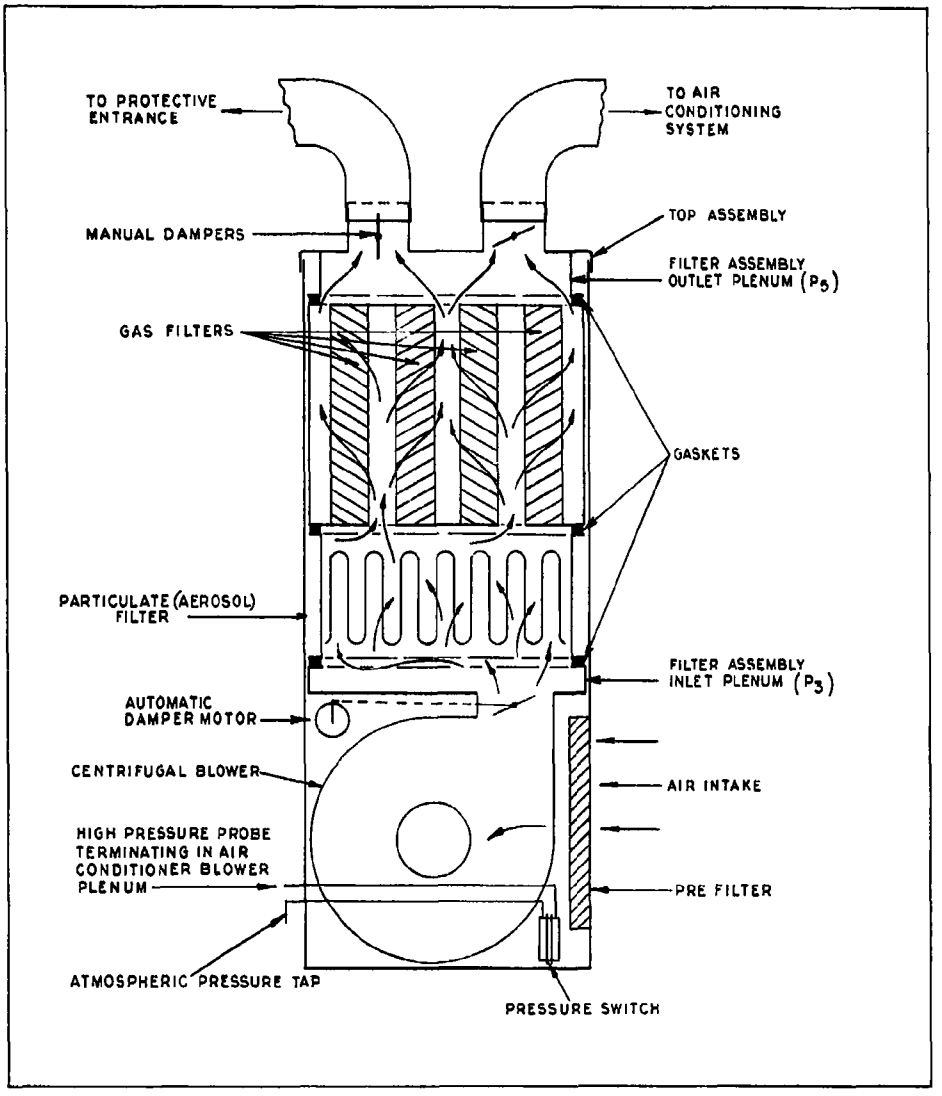


Figure 4. Diagram of 400 CFM Filter Unit.

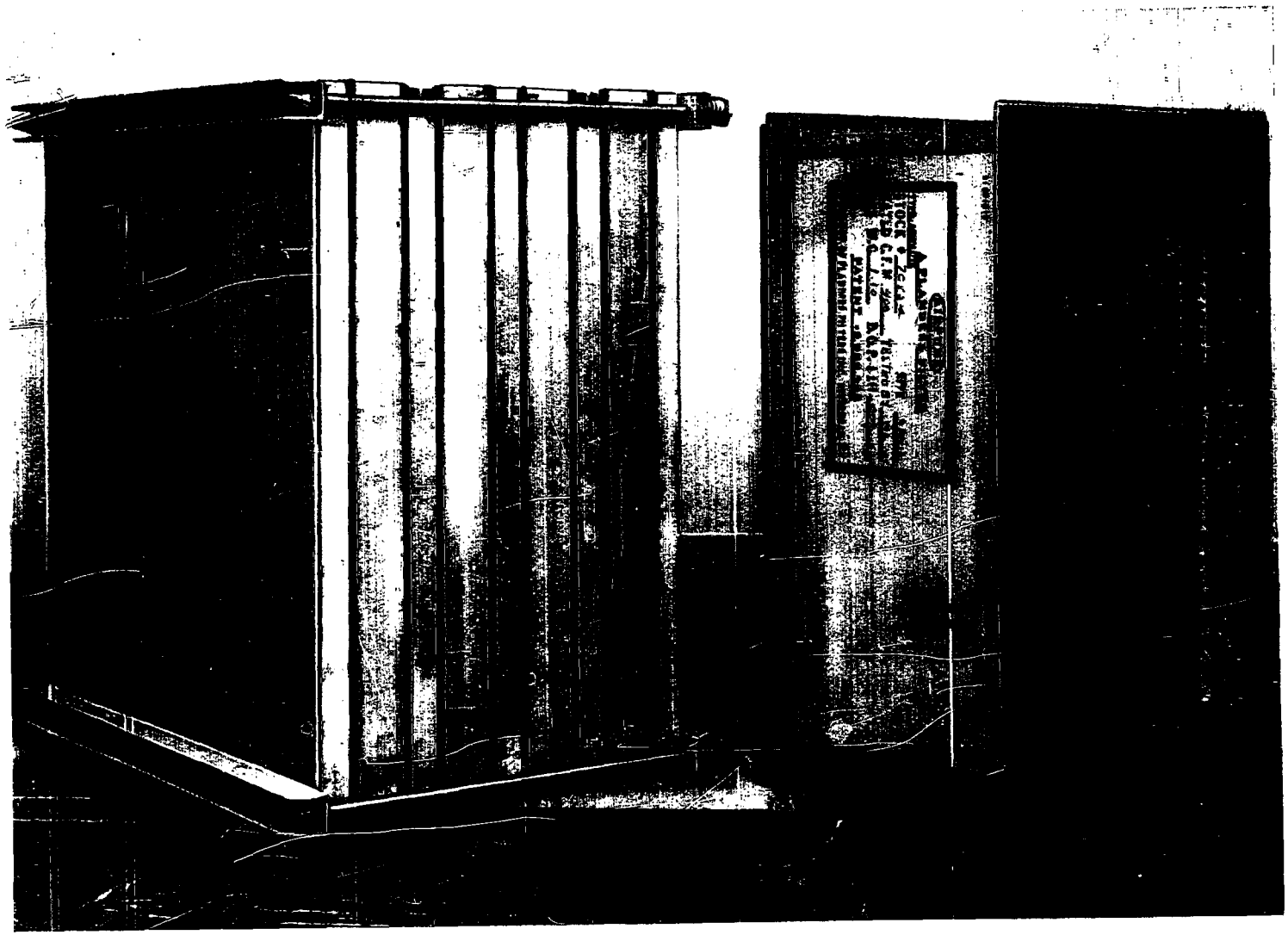


Figure 5. Gas Filter Sub-assembly (Left) and Particulate Filter (Right).

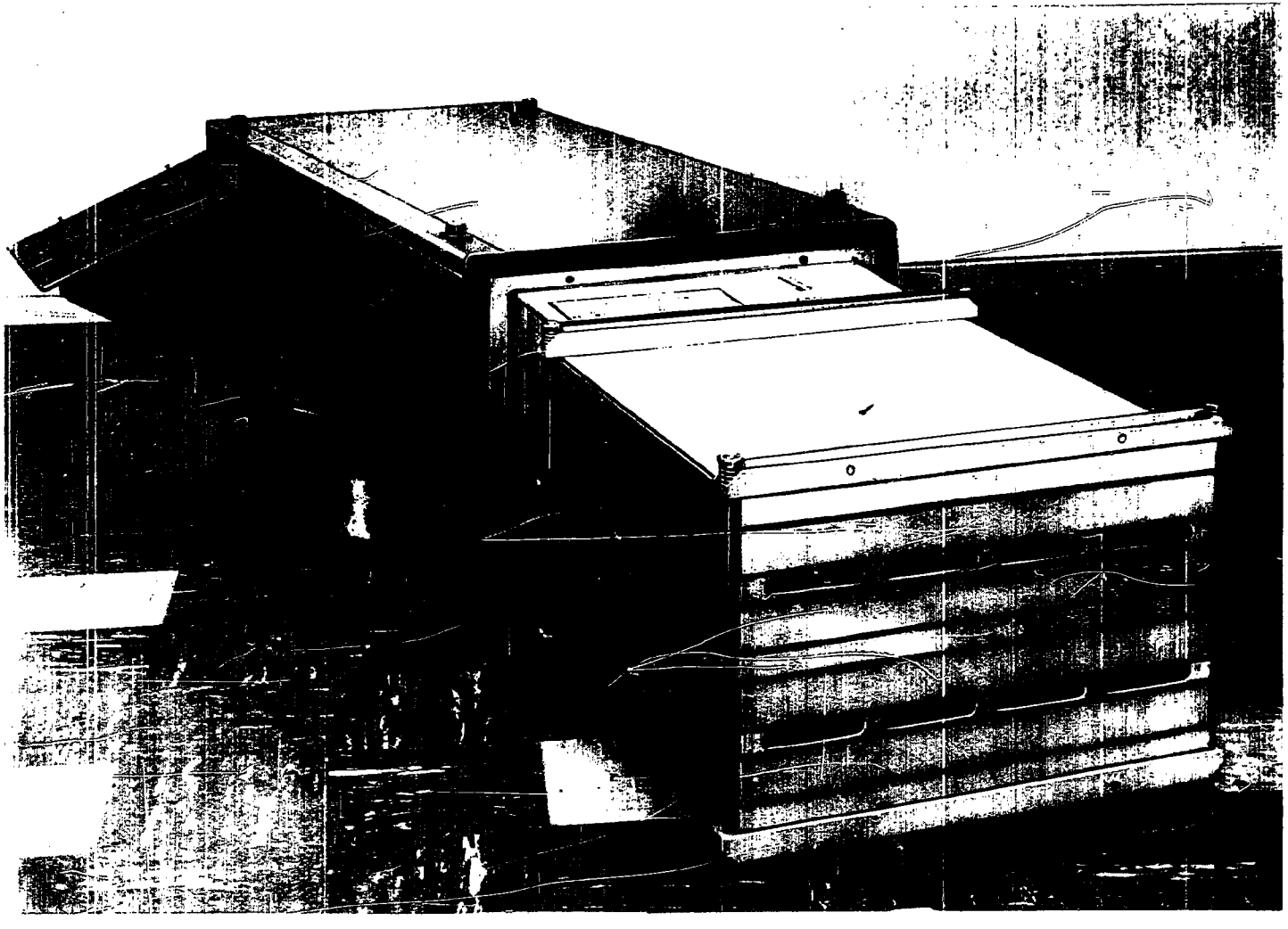


Figure 6. Filter Assembly Partially Inserted into Filter Unit.

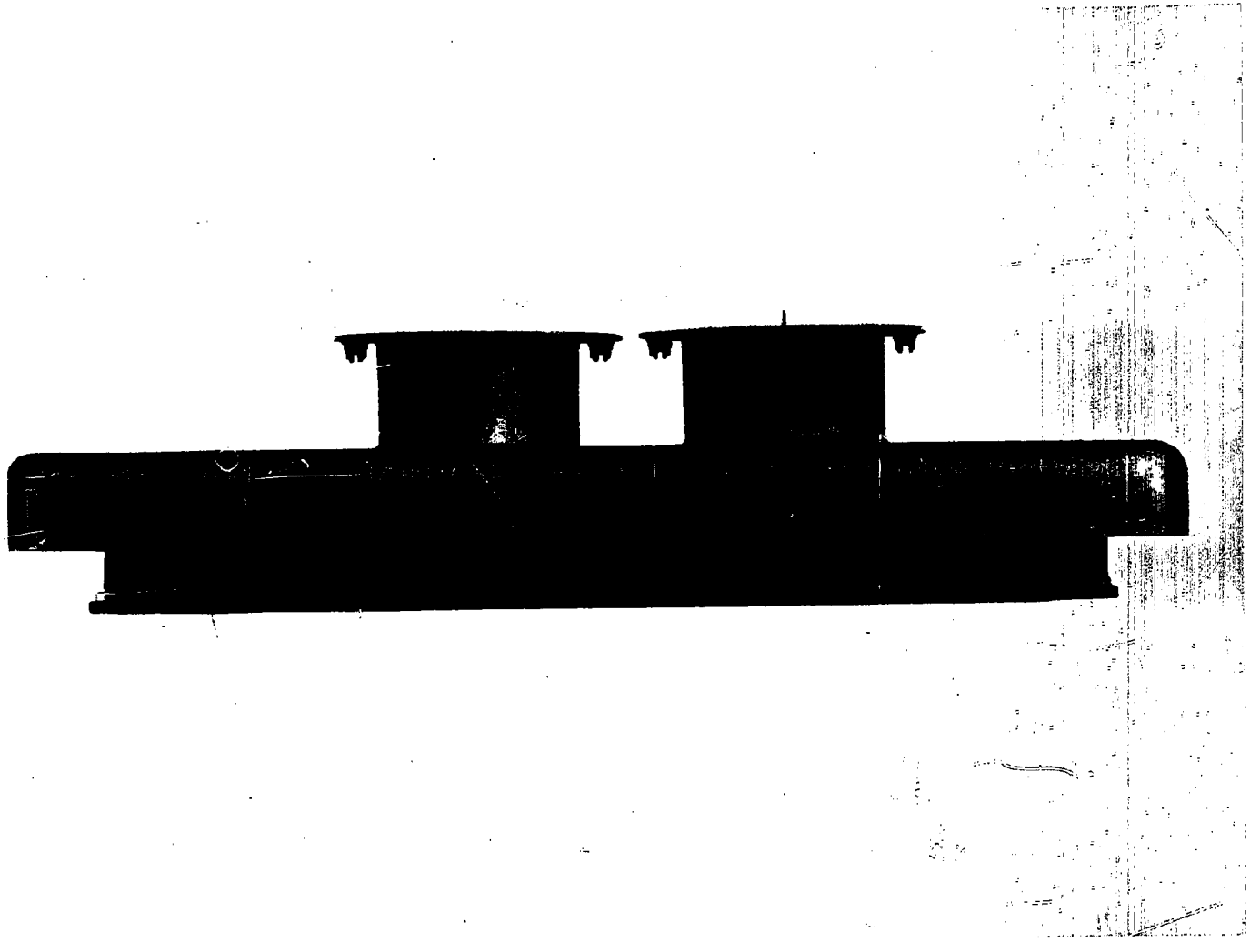


Figure 7. Top Assembly of Filter Unit.

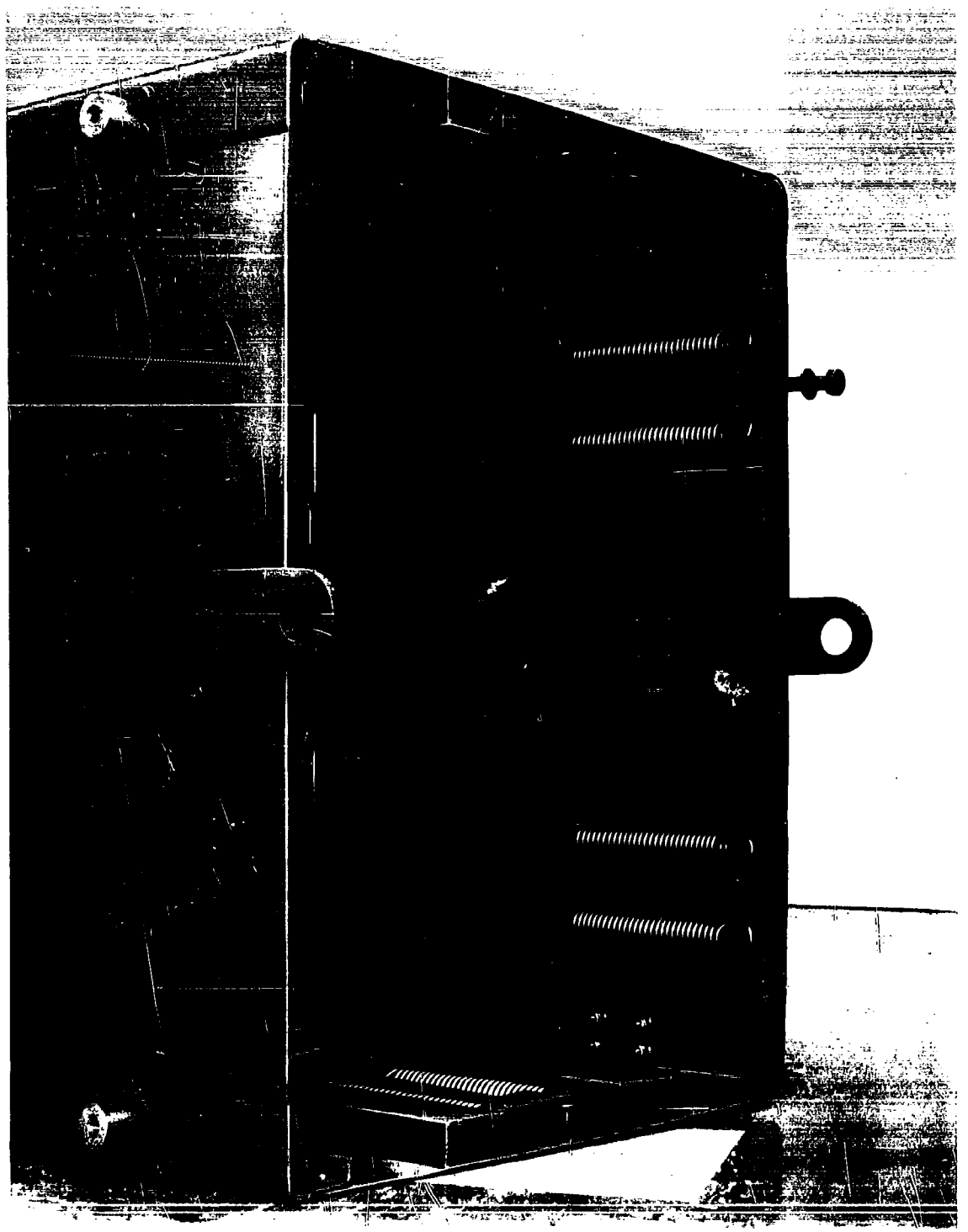


Figure 8. Gasket Compression Spring Assemblies.

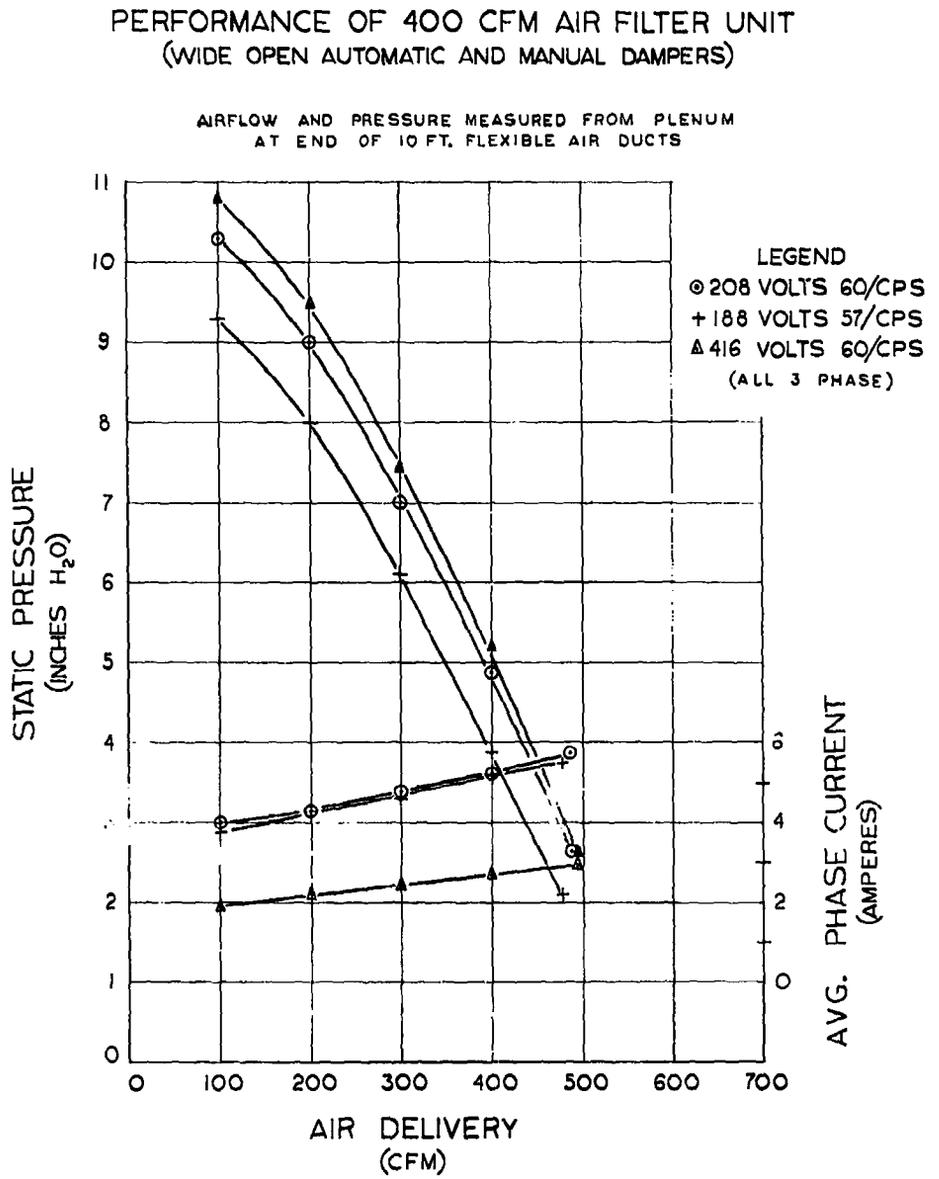

PERFORMANCE OF 400 CFM AIR FILTER UNIT
(WIDE OPEN AUTOMATIC AND MANUAL DAMPERS)
AIRFLOW AND PRESSURE MEASURED FROM PLENUM
AT END OF 10 FT. FLEXIBLE AIR DUCTS
LEGEND
⊙ 208 VOLTS 60/CPS
+ 188 VOLTS 57/CPS
Δ 416 VOLTS 60/CPS
(ALL 3 PHASE)
STATIC PRESSURE
(INCHES H_2O)
AVG. PHASE CURRENT
(AMPERES)
AIR DELIVERY
(CFM)
0
1
2
4
5
6
7
8
9
10
11
100
200
300
400
500
600
700

Figure 9

PERFORMANCE OF PRESSURE CONTROL SYSTEM IN 400 CFM AIR FILTER UNIT

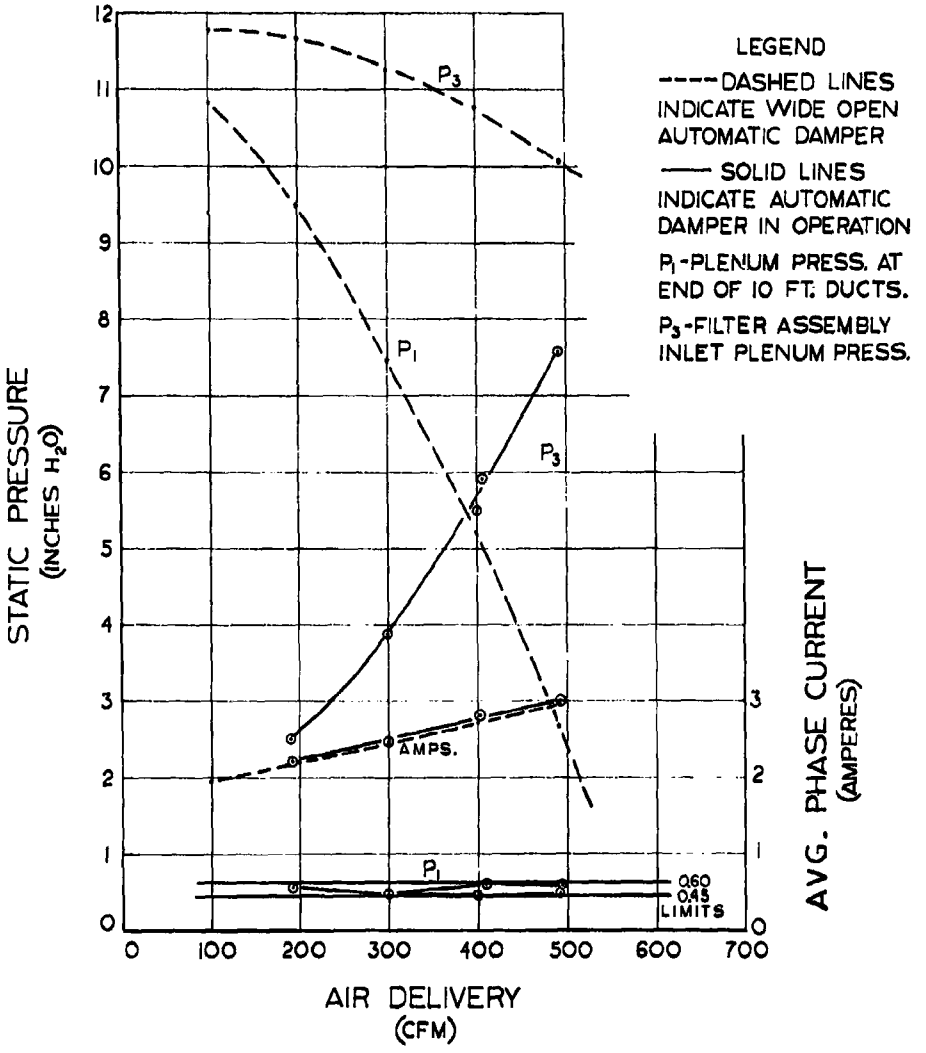


Figure 10

Figure 11. Remote Control Panel.

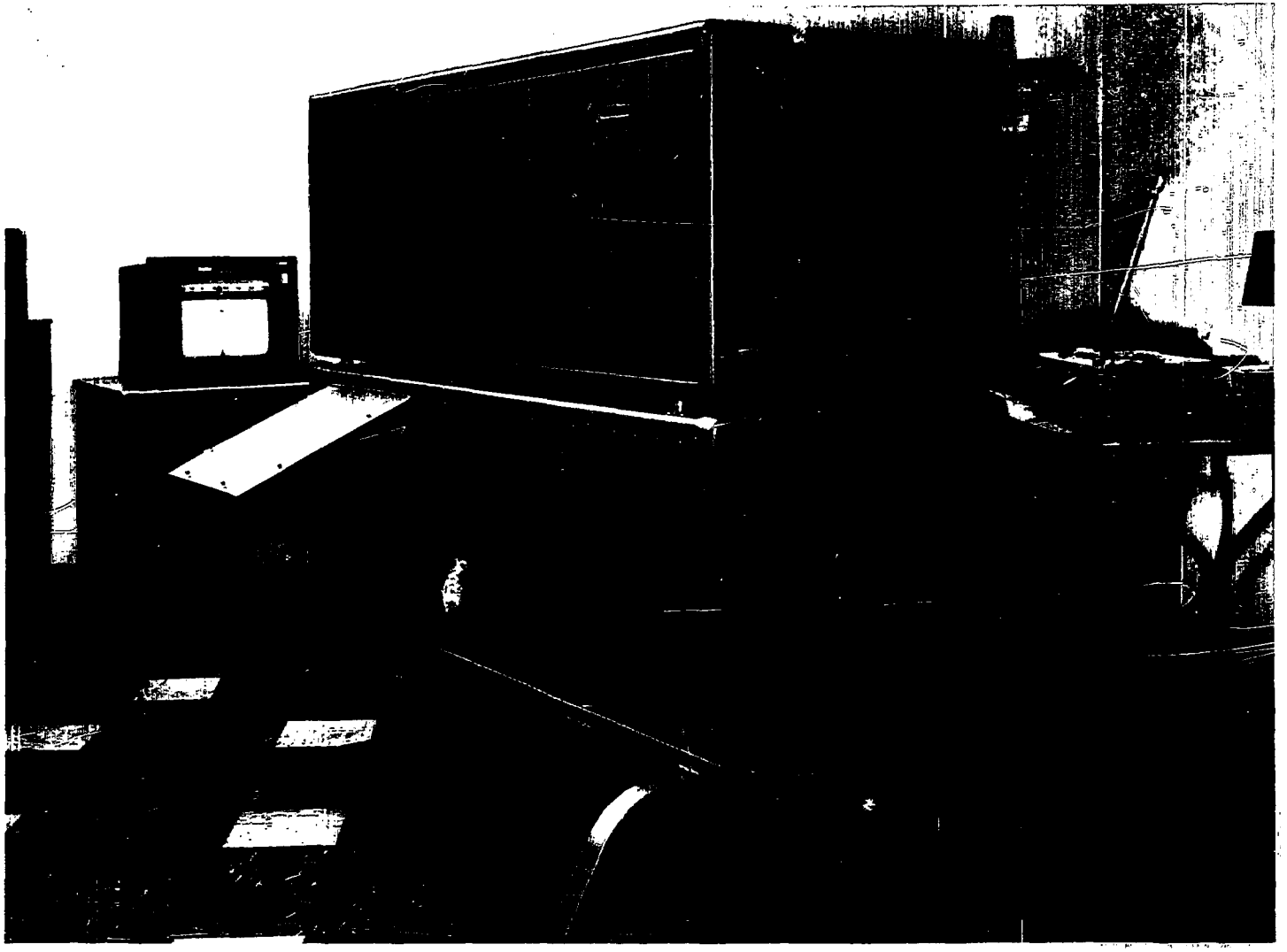


Figure 12. 400 CFM Filter Unit with Storage Box, Mounted on Skid Base.

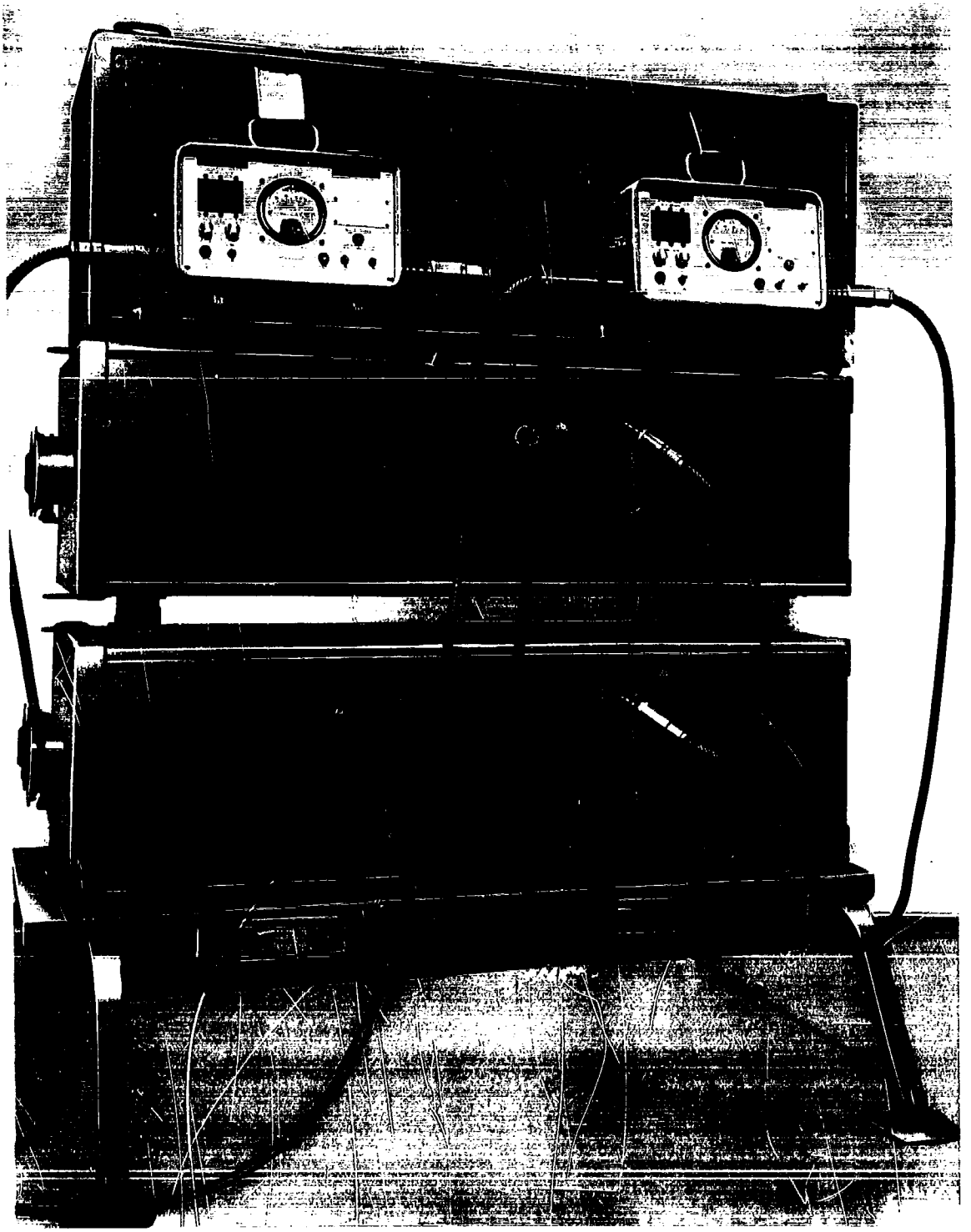
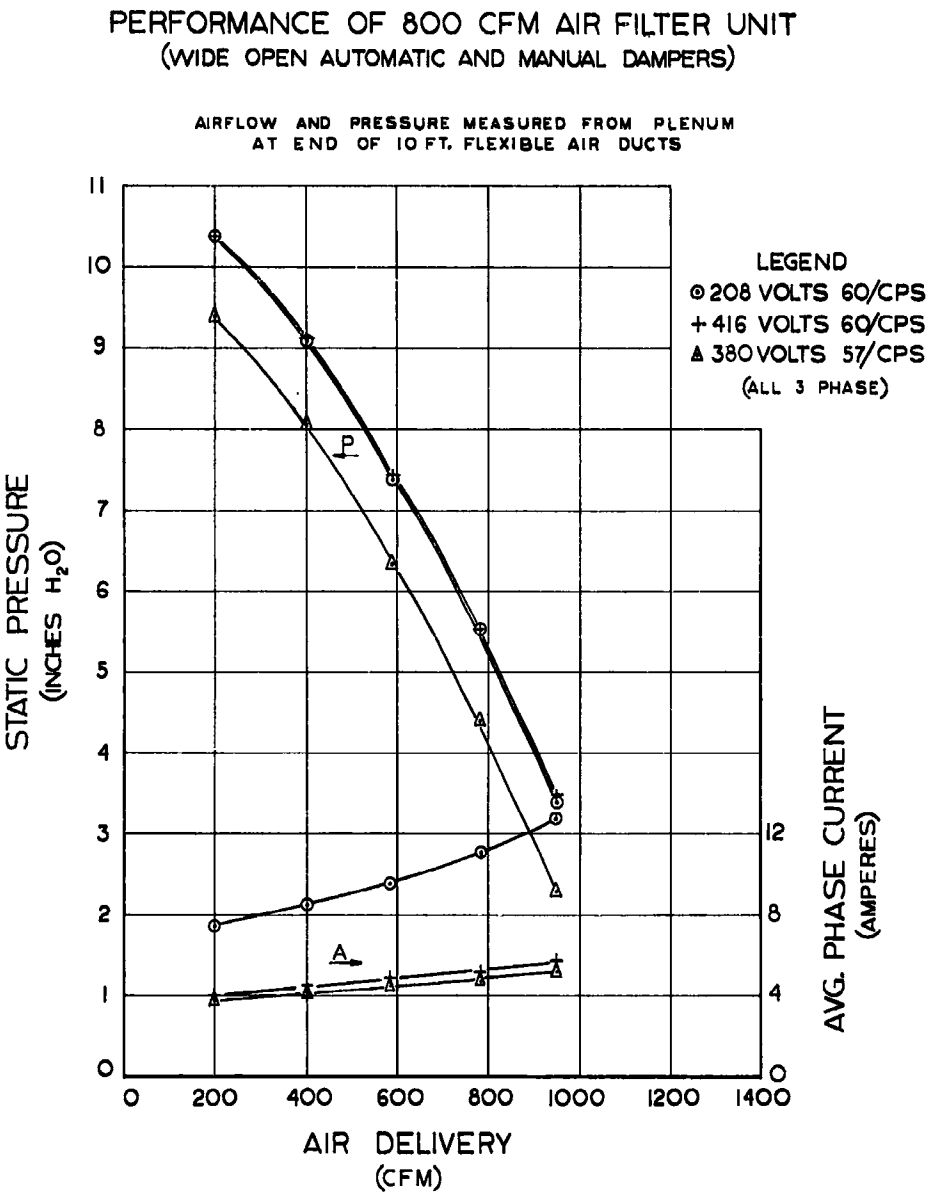


Figure 13. 800 CFM Filter Unit in Operating Configuration.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AT END OF 10 FT. FLEXIBLE AIR DUCTS
LEGEND
⊙ 208 VOLTS 60/CPS
+ 416 VOLTS 60/CPS
△ 380 VOLTS 57/CPS
(ALL 3 PHASE)
STATIC PRESSURE
(INCHES H2O)
AVG. PHASE CURRENT
(AMPERES)
AIR DELIVERY
(CFM)
P
A
0
1
2
3
4
5
6
7
8
9
10
11
12
0
200
400
600
800
1000
1200
1400

Figure 14

PERFORMANCE OF PRESSURE CONTROL SYSTEM IN 800 CFM AIR FILTER UNIT

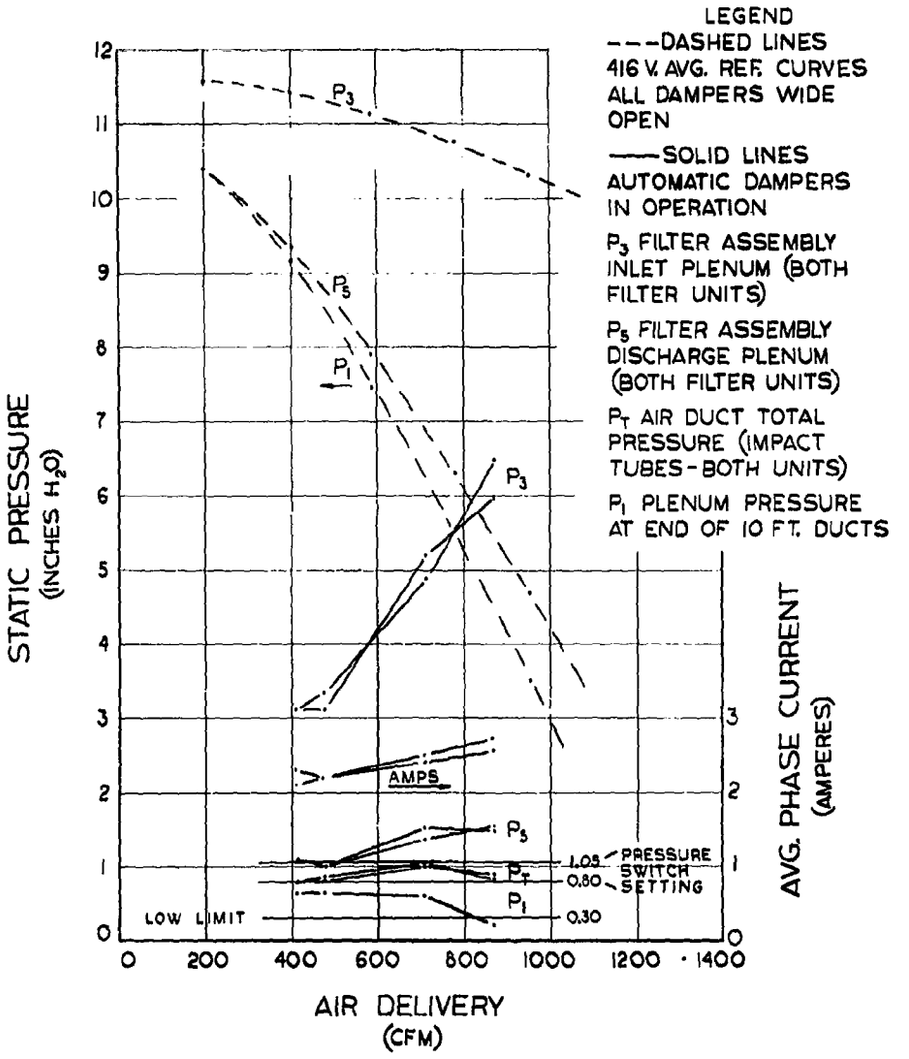

Figure 15

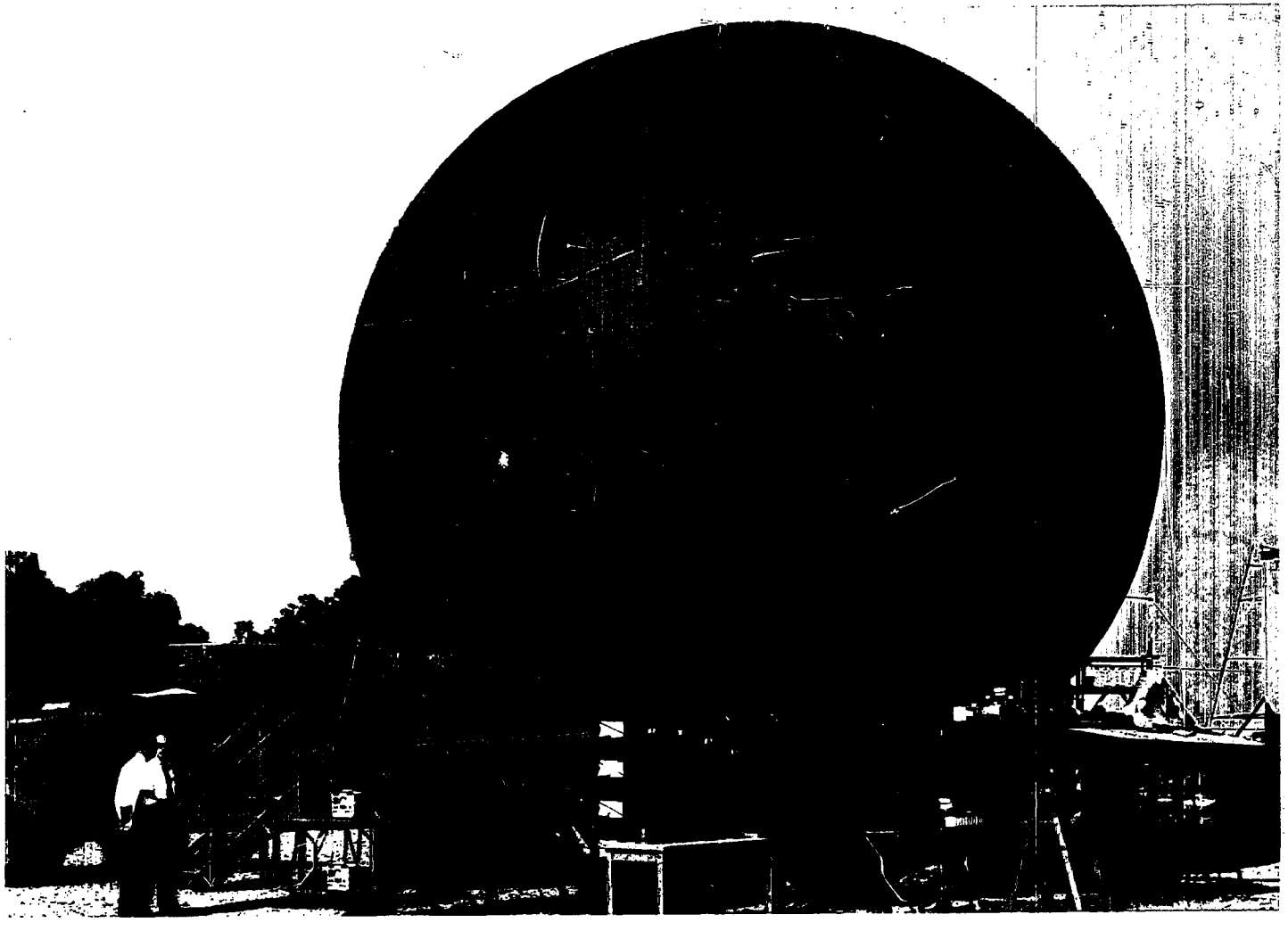

Figure 16. 800 CFM Filter Unit Operational Test with AN/MPS-23 Radar Antenna Trailer.

Figure 17. Leakage Test of Prototype Protective Entrance for AN/MSQ-28 WMC/RDPC Vehicle.

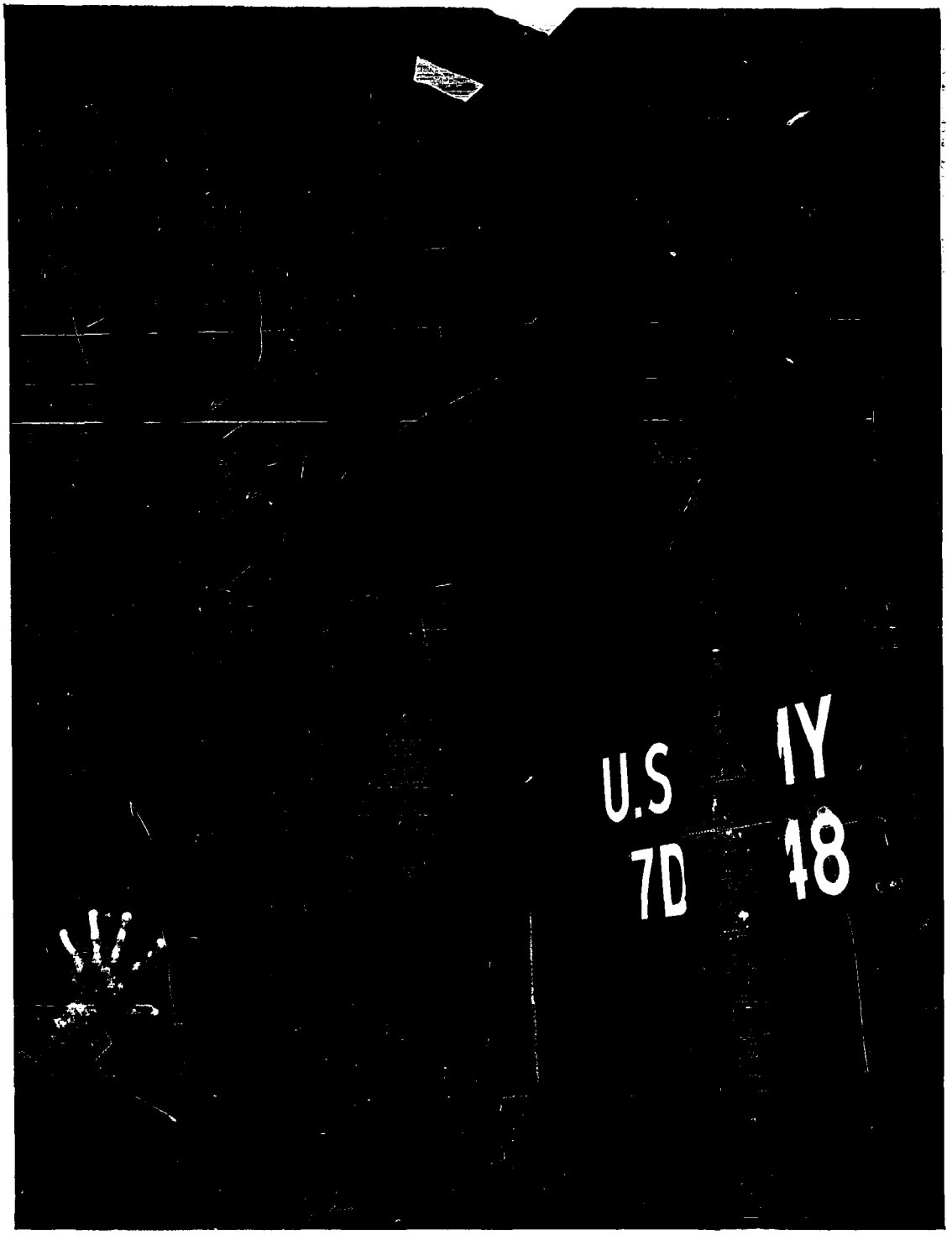

Figure 18. Protective Entrance Secured to WMC Trailer.

Figure 19. Protective Entrance Disposal Chute.

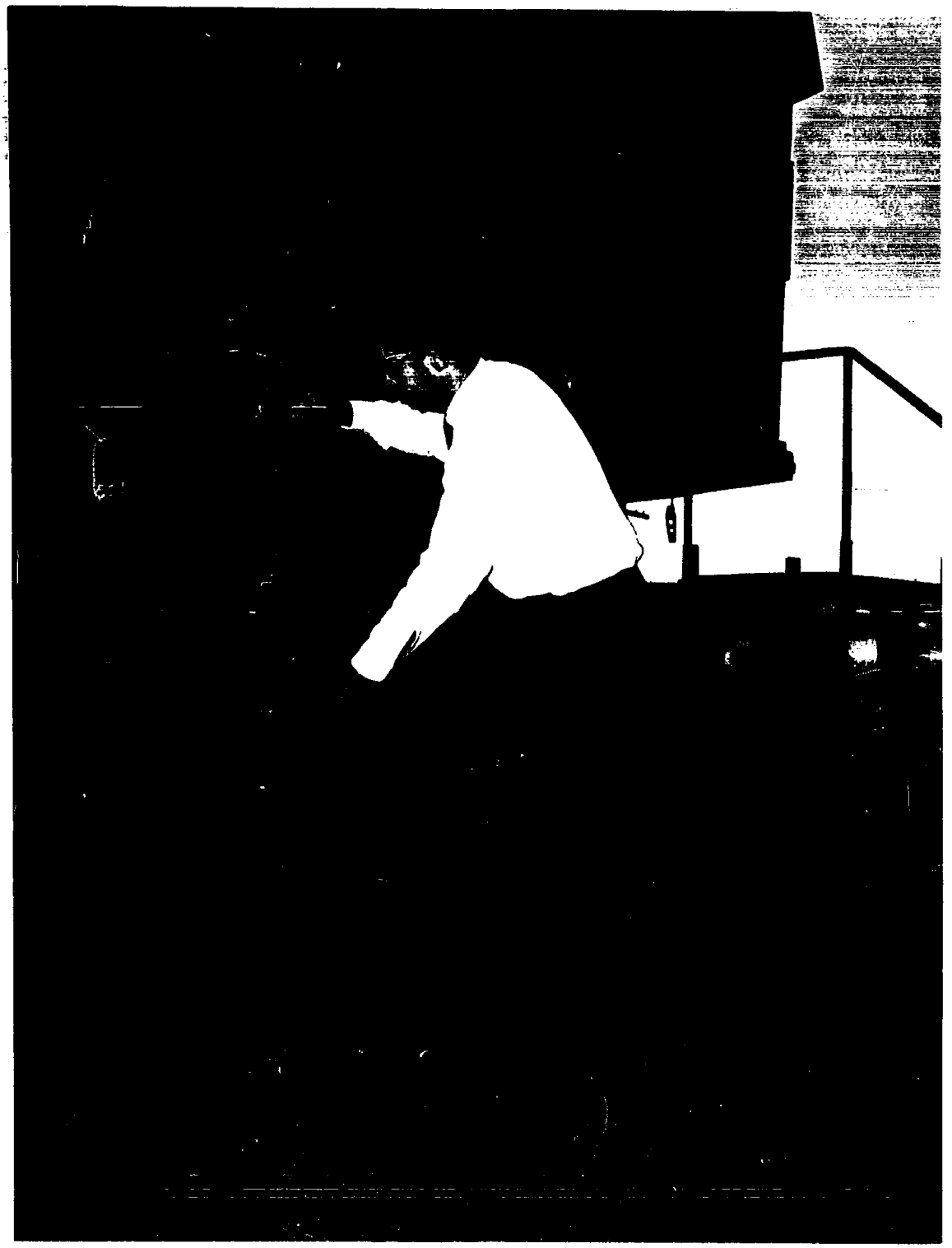

Figure 20. Protective Entrance Personnel Entry and Observation Port.

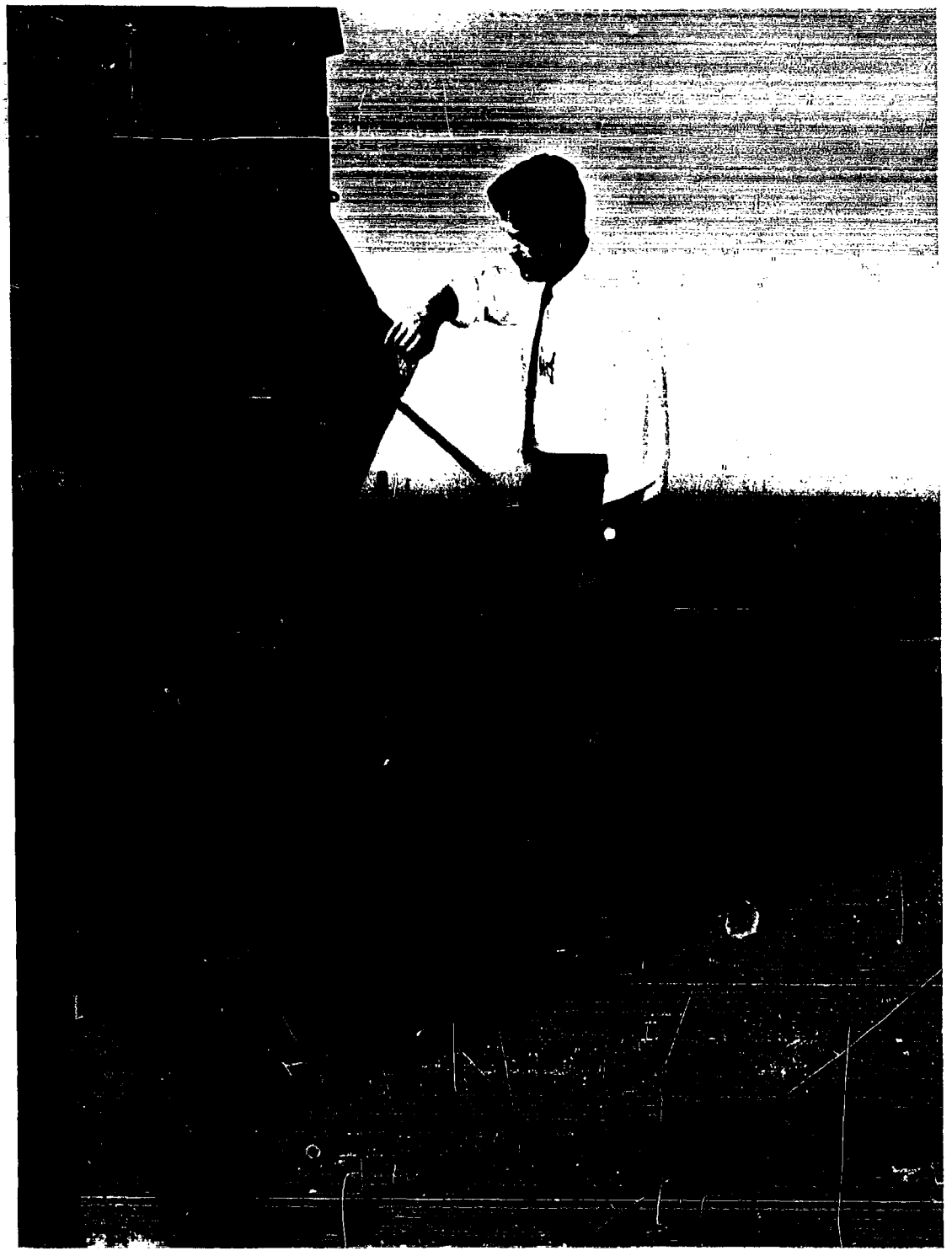

Figure 21. J. Glaser, Project Head Demonstrating Prototype Protective Entrance to Contract Project Officer, M. D. Mears.

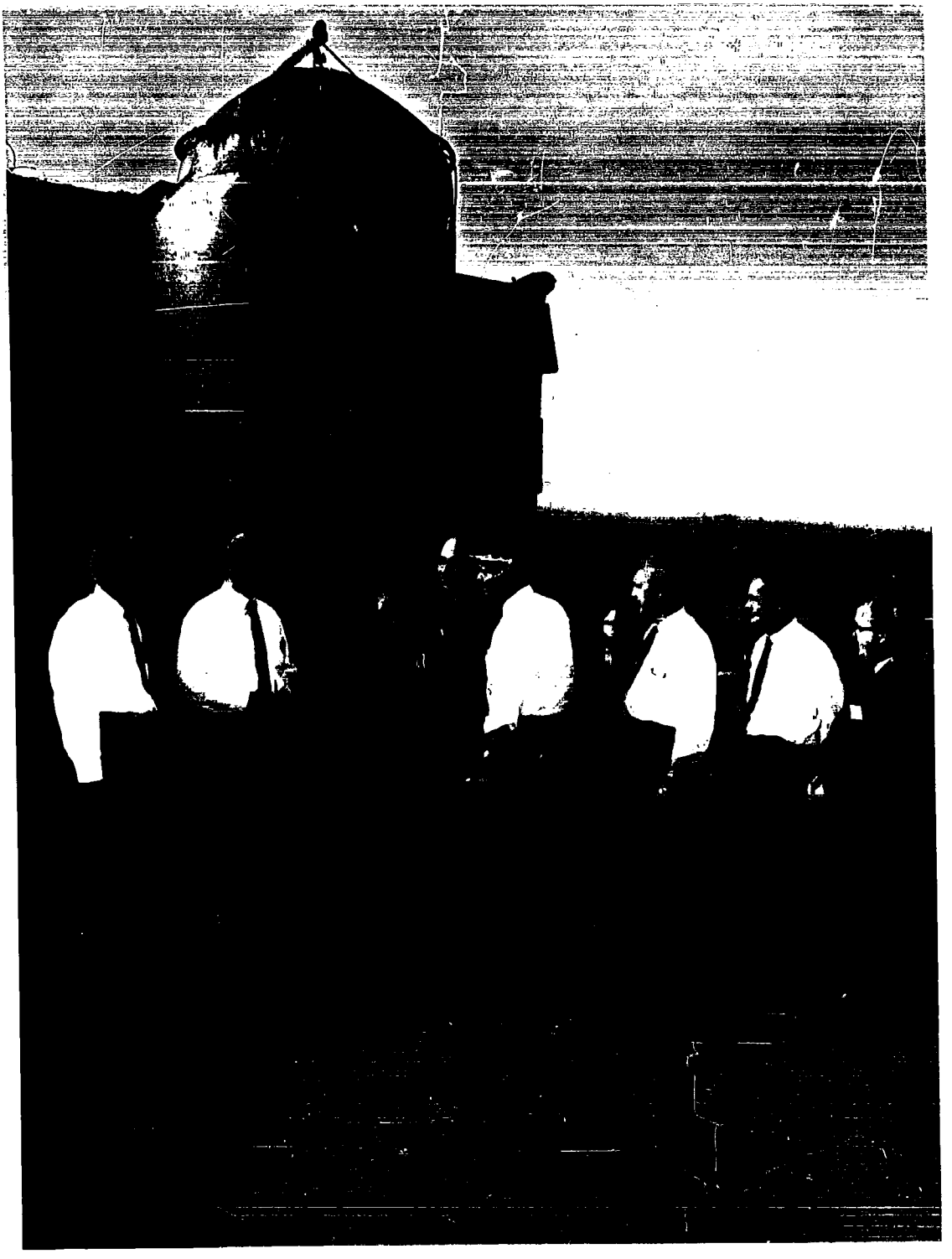

Figure 22. Customer Representatives Inspecting Inflated Protective Entrance.

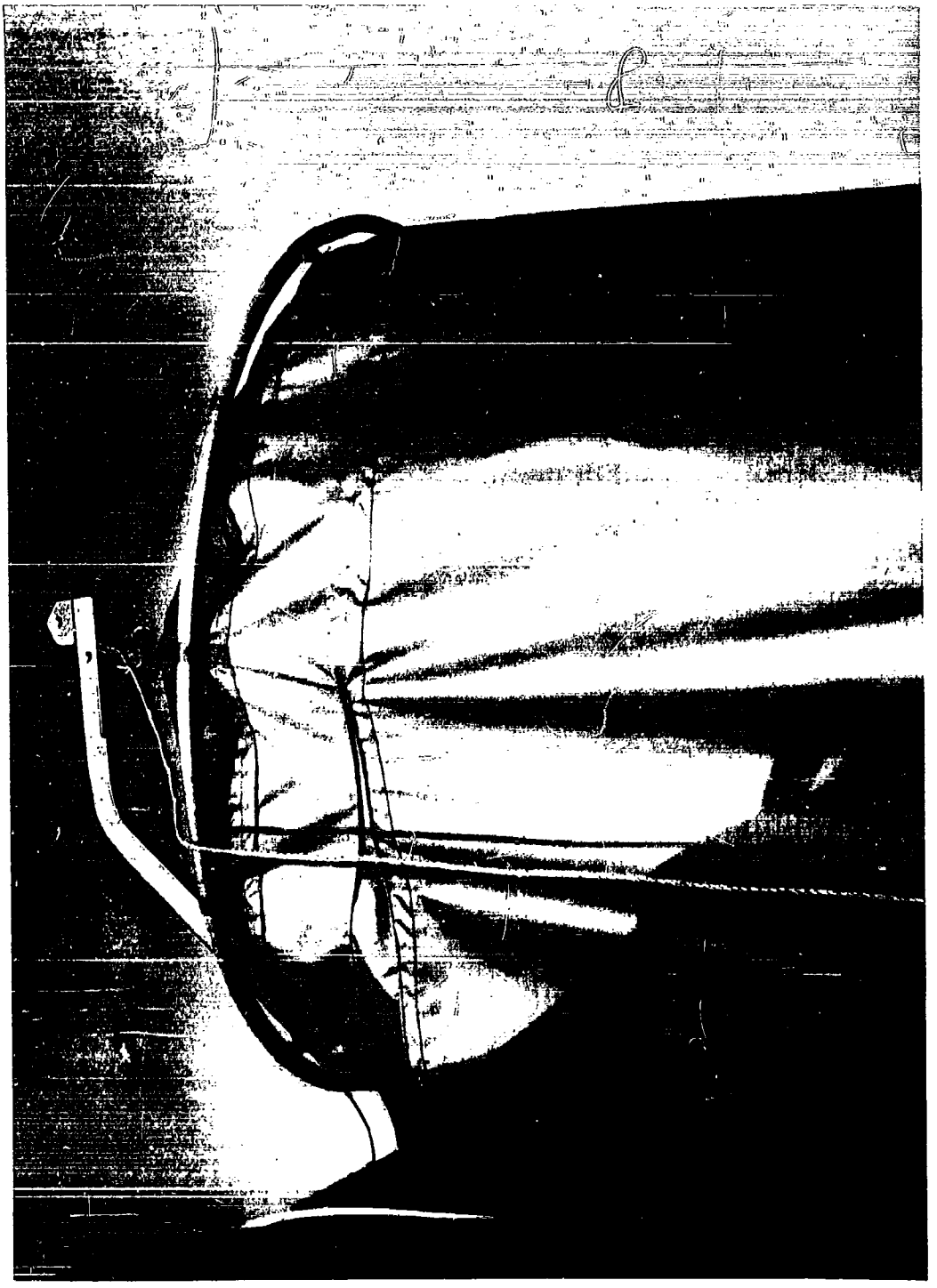

Figure 23. Protective Entrance Support Structure.

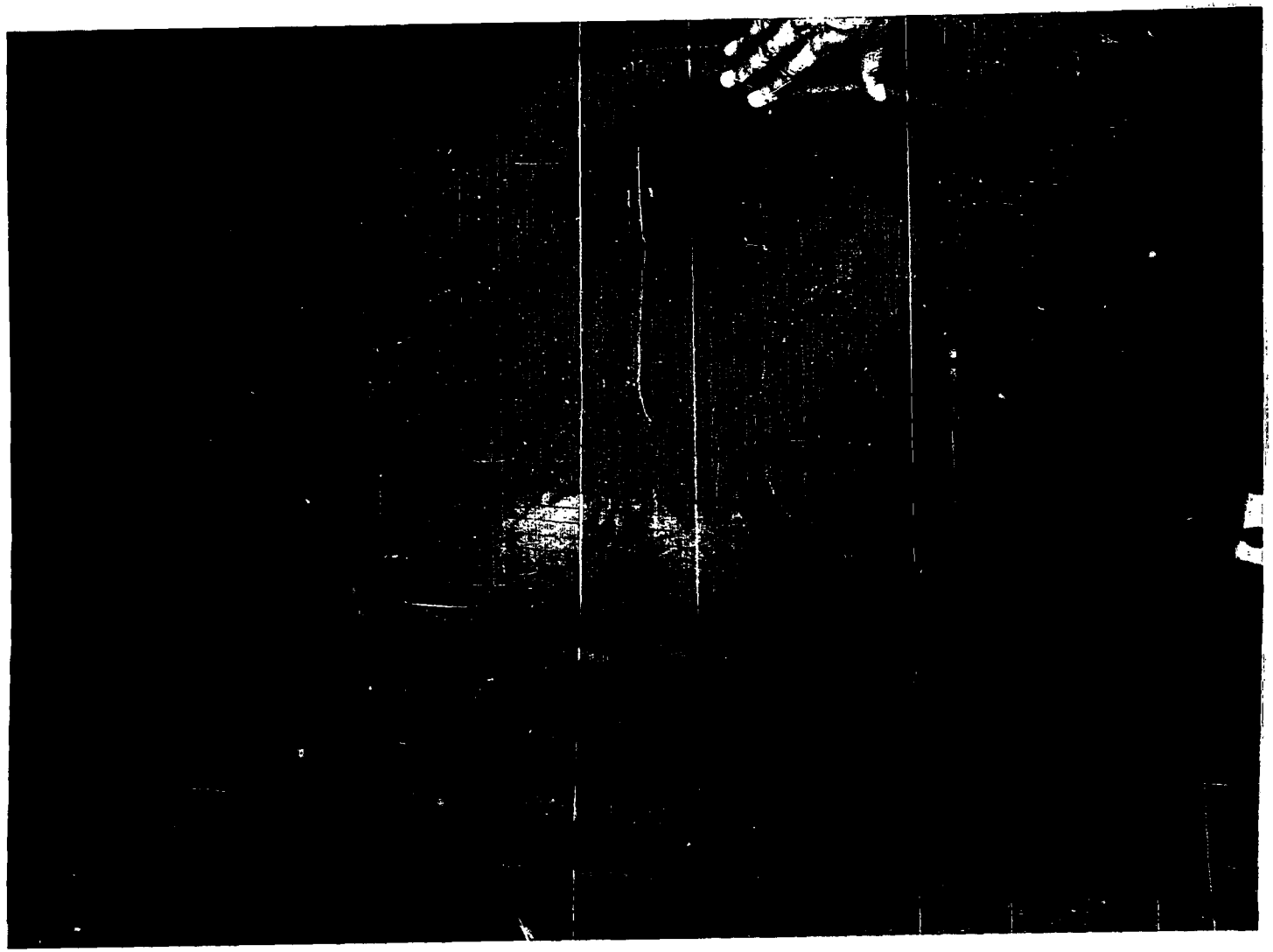

Figure 24. Protective Entrance Scavenging Ports and Ground Leveling Feature.

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